

WHAT IS CLAIMED IS:

1. A surface emitting laser, comprising:

an active region, comprising a plurality of quantum wells, formed between first and second mirrors, wherein gain of each of said quantum wells or groups of quantum wells operate quasi-independently at different temperatures such that stimulated emission is dominated by a different quantum well or group of quantum wells at different temperatures.

2. The surface emitting laser of claim 1 wherein thickness of said quantum wells varies from well to well or between groups of wells so that transition energy and therefore gain peak wavelength varies from well to well or between groups of wells.

3. The surface emitting laser of claim 1 wherein material composition of said quantum wells varies from well to well or between groups of wells to provide varying conduction and valence band offsets between the quantum wells and associated barrier layers.

4. The surface emitting laser of claim 1 wherein said active region further comprises a barrier layer sandwiched between each of said quantum wells, wherein thickness of said barrier layers varies from barrier to barrier or between groups of barriers so that transition energy and therefore gain peak wavelength varies from well to well or between groups of wells.

5. The surface emitting laser of claim 1 wherein said active region further comprises a barrier layer sandwiched between each of said quantum wells, wherein material composition of said barrier layers varies from barrier to barrier or between groups of barriers so that transition energy and therefore gain peak wavelength varies from well to well or between groups of wells.

6. The surface emitting laser of claim 1 wherein material composition of said quantum wells varies from well to well or between groups of wells to induce varying

levels of strain from quantum well to quantum well or between groups of quantum wells to provide varying conduction and valence band offsets between the quantum wells and associated barrier layers.

5 7. The surface emitting laser of claim 1 wherein said quantum wells are gain matched such that the fraction of carriers contributing to stimulated emission is substantially constant over temperature.

10 8. The surface emitting laser of claim 7 wherein thickness of said quantum wells decreases from well to well or between groups of wells, such that each well or group of wells operate at roughly the same internal efficiency η_i at different temperatures.

15 9. The surface emitting laser of claim 7 wherein said active region further comprises a barrier layer sandwiched between each of said quantum wells, wherein material composition of said barrier layers varies from barrier layer to barrier layer or between groups of barrier layers, so that the barrier layer with greatest band offset provides majority of gain at a high operating temperature and the barrier layer with lowest band offset provides majority of gain at a low operating temperature.

20 10. The surface emitting laser of claim 7 wherein material composition of said quantum wells varies from well to well or between groups of wells to provide varying conduction and valence band offsets between the quantum wells and associated barrier layers such that each well or group of wells operate at roughly the same η_i and η at different temperatures

25 11. The surface emitting laser of claim 7 wherein material composition of said quantum wells varies from well to well or between groups of wells to induce varying levels of strain from quantum well to quantum well or between groups of quantum wells such that quantum well with the highest strain provides majority of gain at a high
30 operating temperature and quantum well with lowest strain provides majority of gain at a low operating temperature.

12. The surface emitting laser of claim 7 wherein a first group of wells comprising a first number of wells provides majority of gain at a high operating temperature and a second group of wells comprising a second number of wells provides majority of gain at a low operating temperature and wherein the first number of wells is greater than the second number of wells.

13. The surface emitting laser of claim 7 wherein optical confinement factor varies from well to well or between group wells levels such that the quantum well having largest optical confinement factor provides majority of gain at a high operating temperature and the quantum well having the smallest optical confinement factor provides majority of gain at a low operating temperature.

14. The surface emitting laser of claim 7 wherein said laser further comprises an anode for injecting holes into said active region and wherein the quantum well that supplies majority of gain at a high operating temperature is closest to said anode and wherein the quantum well that supplies majority of gain at a low operating temperature is further from said anode.

15. The surface emitting laser of claim 7 wherein level of non-radiative recombination centers varies from well to well or between groups of wells, and wherein the quantum well with least number of non-radiative recombination centers provides majority of gain at a high operating temperature and the quantum well with the most non-radiative recombination centers provides majority of gain at a low operating temperature.

16. A method for forming a temperature insensitive surface emitting laser, comprising the steps of:

forming an active region on a first mirror, wherein said active region comprises a plurality of gain separated quantum wells that operate quasi-independently over temperature and wherein said quantum wells are gained matched such that fraction of carriers that contribute to stimulated emission is substantially constant over temperature; and forming a second mirror on said active region.

17. The method of claim 16 wherein the step of forming a plurality of gain separate quantum wells comprises forming a plurality of quantum wells having varying thickness.

5 18. The method of 17 wherein the step of forming a plurality of quantum wells having varying thickness comprises varying thickness of said quantum well so that each well or group of wells dominates operation of the surface emitting laser over a predetermined temperature range.

10 19. The method of claim 18 wherein the step of forming a plurality of gain matched quantum wells comprises forming a plurality of quantum wells having varying gain enhancement factor.

15 20. The method of 19 wherein the step of forming a plurality of quantum wells having varying gain enhancement factor comprises varying the gain enhancement factor of said quantum wells so that η is substantially constant over temperature.